

1 **SECTION 9-29, ILLUMINATION, SIGNAL, ELECTRICAL**  
2 **August 3, 2009**

3 **9-29.1 Conduit, Innerduct, and Outerduct**

4 This section's content is deleted. This section is supplemented with the following:

5  
6 Conduit shall be free from defects, including out of round, and foreign inclusions.  
7 Conduit shall be uniform in color, density, and physical properties. The inside shall be  
8 smooth and free from burrs which could damage cable during installation. Conduit ends  
9 shall be cut square to the inside diameter, and supplied with thread protectors. All  
10 conduit, conduit fittings, and associated hardware/appurtenances shall be listed by a  
11 Nationally Recognized Testing Laboratory.  
12

13 **9-29.1(1) Rigid Metal Conduit, Galvanized Steel Outerduct, and Fittings**

14 Rigid metal conduit, shall be straight, and be rigid galvanized steel, or stainless steel, as  
15 required and bear the mark of a Nationally Recognized Testing Laboratory. Exterior and  
16 interior surfaces of the galvanized steel conduit, except threaded ends, shall be  
17 uniformly and adequately zinc coated by a hot-dip galvanizing process. The average of  
18 the zinc coating shall comply with Federal Specification WW-C-581d.  
19

20 **9-29.1(2) Rigid Metal Conduit Fittings and Appurtenances**

21 Couplings for rigid metal type conduits may be either hot-dip or electroplated  
22 galvanized.  
23

24 Conduit bodies and fittings for rigid steel conduit systems shall be listed by Nationally  
25 Recognized Testing Laboratory listed for wet locations, and shall be hot-dip galvanized  
26 malleable iron, or bronze. Conduit bodies shall have tapered threads, and include a bolt  
27 on cover with stainless steel screws and a neoprene gasket seal.  
28

29 Grounding end bushings shall be bronze or galvanized malleable iron with copper,  
30 tinned copper, stainless steel, or integral lug with stainless steel clamping screw,  
31 mounting screw and set screw.  
32

33 Conduit clamps and straps shall be type 304 or type 316 stainless steel or hot-dip  
34 galvanized. Two-hole type straps shall span the entire width of the support channel and  
35 attach to the supports on both sides of the conduit with bolts and associated hardware.  
36 Two piece conduit clamps shall interlock with the support channel with a single bolt.  
37

38 Conduit supports for surface mounted conduit shall be hot-dip galvanized or type 304 or  
39 type 316 stainless steel channel using type 304 or type 316 stainless steel bolts and  
40 spring nuts.  
41

42 **9-29.1(2)A Expansion Fittings, Deflection Fittings, and Combination**  
43 **Expansion/Deflection Fittings**

44 Expansion fittings for rigid galvanized steel conduit shall be weather tight, with hot-dip  
45 galvanized malleable or ductile iron end couplings and body and shall allow for 4-inches  
46 of movement minimum (2-inches in each direction). Expansion fittings for rigid  
47 galvanized steel conduit shall have an external tinned copper bonding jumper or an  
48 internal tinned copper bonding jumper. The internal tinned copper bonding jumper shall  
49 not reduce the conduit conductor capacity.  
50

1 Deflection fittings for rigid galvanized steel conduit shall be weather tight, with hot-dip  
2 galvanized ductile iron or bronze end couplings, with molded neoprene sleeve, stainless  
3 steel bands and internal tinned copper bonding jumper. Deflection fittings shall provide  
4 for conduit movement of 3/4-inch in all directions and angular movement of 30 degree in  
5 any direction.  
6

7 A combination of a deflection and an expansion fitting for rigid galvanized steel conduit  
8 shall be assembled from a deflection fitting and an expansion fitting as defined above.  
9

10 The bonding jumper used for expansion fittings and combination expansion deflection  
11 fittings shall be a tinned copper braid attached to the conduit with a galvanized "U" bolt  
12 type connection designed for the application.  
13

### 14 **9-29.1(3) Flexible Metal Conduit**

15 Liquidtight flexible metal conduit shall consist of a single strip of continuous flexible  
16 interlocked steel galvanized inside and out, forming a smooth internal wiring channel  
17 with a liquid tight covering of sunlight resistant flexible PVC conforming to NEC Article  
18 350.  
19

### 20 **9-29.1(3)A Flexible Metal Conduit Appurtenances**

21 Liquidtight connectors shall be the insulated throat type, conforming to NEC Article 350,  
22 and listed for wet locations.  
23

### 24 **9-29.1(4) Non-Metallic Conduit**

#### 25 **9-29.1(4)A Rigid PVC Conduit**

26 Rigid PVC conduit shall conform to NEMA TC 2 and ASTM F 2136, and UL 651.  
27 Fittings shall conform to NEMA TC-3, and be UL 514C and UL 651.  
28  
29

30 PVC solvent cement shall meet ASTM D 2564 including note 8 (label to show pipe sizes  
31 for which the cement is recommended).  
32

#### 33 **9-29.1(4)B HDPE Conduit**

34 HDPE conduit shall be listed by a Nationally Recognized Testing Laboratory. Couplings  
35 for HDPE shall be mechanical and listed for use with HDPE.  
36

37 Aluminum mechanical couplings are prohibited.  
38

### 39 **9-29.1(5) Innerduct and Outerduct**

40 The innerduct system shall be factory-installed and shall be designed so that expansion  
41 and contraction of the innerducts takes place in the coupling body to eliminate  
42 compatibility problems. The conduit coupling body shall have a factory-assembled  
43 gasket that is multi-stage and anti-reversing, sealing both the outerduct and innerducts.  
44 A secondary mid-body O-ring gasket shall be seated into the coupling body and shall  
45 hold the coupling body firmly in the outerduct.  
46

47 All fittings, adapters, and bends (sweeps) shall be provided and shall be manufactured  
48 from the same materials and manufacturing process as the conduit, except as specified  
49 otherwise. The conduit system shall be a complete system with the following  
50 accessories:  
51

52 Manhole Terminator Kits

- 1 Deflection Fittings
- 2 Offset Fittings
- 3 Expansion/Contraction Fittings
- 4 Repair Kits
- 5 Conduit and Innerduct Plugs
- 6 Pull string
- 7 Pull rope
- 8 Conduit spacers
- 9 Split Plugs

10

11 **9-29.1(5)A Rigid Galvanized Steel Outerduct with PVC or PE Innerduct**

12 Each section of steel outerduct shall be supplied with one reversing spin coupling that  
13 allows straight sections and fittings to be joined without spinning the conduit. The  
14 reversing coupling shall be galvanized and have three setscrews or a lock nut ring to  
15 lock the coupling in place. Setscrews or lock nut ring shall be galvanized or stainless  
16 steel and insure continuous electrical ground. The couplings shall be galvanized steel  
17 with the same material properties as the conduit.

18

19 The conduit system shall be designed so that assembly of components can be  
20 accomplished in the following steps:

21

22 1. Loosen setscrews or lock nut ring on coupling and spin back to allow for  
23 insertion.

24

25 2. Spin coupling mating sections forward to bottom.

26

27 3. Tighten setscrews on lock nut ring.

28

29 **9-29.1(5)B Rigid PVC Outerduct with PVC or PE Innerduct**

30 Protective outerduct for schedule 40 PVC and schedule 80 PVC conduit outerduct shall  
31 be 4-inch with a minimum 5-inch extended integral "bell end" and shall be gray in color.  
32 The outerduct minimum wall thickness shall be 0.23-inch for Schedule 40 PVC and  
33 0.32-inch for Schedule 80 PVC.

34

35 Conduit and fittings for PVC outerduct shall be manufactured with an ultraviolet inhibitor.

36

37 The coupling body for PVC outerduct shall include a factory-assembled, multi-stage  
38 gasket that is anti-reversing, sealing both the outer and innerducts. A secondary mid-  
39 body gasket shall be seated at the shoulder of the bell to assure air and water integrity  
40 of the system. The bell end and the coupling body assembly shall accept a minimum of  
41 5-inches of the spigot end.

42

43 The conduit system shall be designed so that straight sections and fittings will assemble  
44 without the need for lubricants or cement.

45

46 PVC outerduct shall have a longitudinal print-line that denotes "Install This Side Up" for  
47 proper innerduct alignment. PVC outer-ducts shall have a circumferential ring on the  
48 spigot end of the duct to provide a reference point for ensuring the proper insertion  
49 depth when connecting conduit ends. The line shall be a minimum of 5-inches from the  
50 end of the conduit.

51

1 **9-29.1(5)C Innerduct for Straight Sections of Galvanized Steel Outerduct**  
2 **or PVC Outerduct**

3 The innerducts shall have a minimum outside diameter of 1.25-inch, and a minimum  
4 inside diameter of 1.2-inch. Larger diameter innerducts may be provided if the wall  
5 thickness and diameter tolerances are met. The tolerance for inside and outside  
6 diameters shall be 0.005-inch. The innerducts shall have a minimum wall thickness of  
7 0.060-inch. Innerduct shall be color coded and shall index a minimum of one innerduct  
8 with a different color. Alternate color codes are permitted as long as the color codes are  
9 contiguous between adjacent junction boxes. The innerducts shall be factory installed in  
10 the outerduct.

11  
12 Dynamic coefficient of friction of innerducts shall be tested in accordance with Telcordia  
13 GR-356-CORE procedure. The coefficient of friction shall be less than 0.30 between  
14 medium density polyethylene jacketed fiber optic cable and the prelubricated innerduct.  
15 The coefficient of friction shall be less than 0.10 between the 1/4-inch diameter  
16 polypropylene rope (suitable for fiber optic cable pulling) and the prelubricated  
17 innerduct. Pull rope used for testing (meeting the 0.10 coefficient of friction requirement)  
18 shall be the same type as the pull rope used for cable installation. The Contractor shall  
19 provide as part of the conduit submittals a certificate of compliance with these  
20 coefficient of friction requirements.

21  
22 The innerduct shall have a smooth, non-ribbed interior surface, with a factory  
23 prelubricated coating. The coating shall provide the required dynamic coefficient of  
24 friction.

25  
26 Innerduct shall be extruded polyvinyl chloride (PVC) or polyethylene (PE).

27  
28 The coupling body for the innerduct shall be factory assembled in the bell end of the  
29 outerduct and shall be manufactured from a high impact engineered thermoplastic. The  
30 coupling body face shall be supplied with lead-ins to facilitate assembly.

31  
32 All outerduct shall be marked with data traceable to plant location.  
33

34 **9-29.1(5)D Conduit with Innerducts Fittings and Appurtenances**

35 Duct plugs shall be polypropylene and be equipped with a neoprene or polyurethane  
36 gasket. Plugs shall be equipped with an attachment to secure the pull rope in the  
37 innerduct. The plug shall withstand 5 psi.  
38

39 **9-29.1(5)D1 Bends for 4-inch PVC Conduit with Innerducts or Galvanized**  
40 **Steel Conduit with Innerducts**

41 All bend radii shall be 36-inches or greater. The conduit system shall provide a complete  
42 line of fixed and flexible sweeps with system compatible bell and spigot or threaded  
43 ends. The bends shall contain high-temperature burn-through-resistant innerducts  
44 manufactured from PVC, PE, or Nylon-66. The innerducts shall meet all other  
45 requirements for innerduct in Sections 9-29.1(1) and 9-29.1(5)A.  
46

47 **9-29.1(5)D2 Prefabricated Fixed and Flexible Bends (for Innerducts)**

48 The prefabricated standard fixed PVC bends shall have a radius between 4-feet and 9-  
49 feet and sweep angles of 11.25-degree, 22.5-degree, 45-degree, or 90-degree.  
50

51 Flexible bends shall be prefabricated. These conduits may be field bent to a uniform  
52 radius no less than 4-feet. The field bend shall be no greater than 90-degrees.

Grounding shall be continuous in flexible bends. Outerduct for flexible ends shall be manufactured from reinforced PVC. Expansion and Deflection fittings for rigid galvanized steel conduit with innerduct shall be provided in accordance with 9-29.1(2)A.

#### **9-29.1(6) Detectable Underground Warning Tape**

Detectable Underground Warning tape shall be Orange imprinted in black lettering with the message; "FIBER OPTIC CABLE BURIED BELOW" or equal. The warning tape shall be polyethylene with a metallic backing. The polyethylene shall be a minimum 4-mils thick and 3-inches wide.

#### **9-29.1(7) Steel Casings**

Steel casing material shall conform to ASTM A 252 Grade 2 or 3 or casing as approved by the Engineer. The Contractor shall furnish pipe of adequate thickness to withstand the forces exerted by the boring operation as well as those forces exerted by the earth during installation and shall be a minimum of 3/8-inch thick. All joints shall be welded by a welder qualified in accordance with AWS D1.1 structural welding code, section 3.

#### **9-29.1(8) Drilling Fluid**

Drilling fluid used for directional boring shall be an inert mixture of water and bentonite clay, conforming to the drilling equipment manufacturers recommendations.

### **9-29.2(1) Standard Duty and Heavy Duty Junction Boxes**

The second paragraph is revised to read:

Standard Duty Junction Boxes are defined as Type 1, 2, and 8, and Heavy Duty Junction Boxes are defined as Type 4, 5, and 6.

#### **9-29.2(1)A Standard Duty Junction Boxes**

The second sentence of the first paragraph is revised to read:

A complete Type, 8 Junction Box includes the spread footing shown in the Standard Plans.

The materials list in the third paragraph under Concrete Junction Boxes is supplemented with the following:

Bolts, Nuts, Washers ASTM F 593 or A 193, type 304 or 316

The third sentence in the second paragraph under Non-concrete Junction Boxes is revised to read:

Non-concrete junction box lids shall include a pull slot, embedded 6" X 6" X 1/4" steel plate and shall be secured with two 1/2 inch stainless steel hex-head bolts factory coated with anti-seize compound and recessed into the cover.

#### **9-29.2(1)C Testing Requirements**

The paragraph under Testing for the Standard Duty non-concrete Junction Boxes is revised to read:

Non-concrete Junction Boxes shall be tested as defined in the ANSI/SCTE 77-2007 Tier 22 test method with design load minimum of 22,500lbs . In addition the Contractor shall

1 provide a Manufacture Certificate of Compliance for each non-concrete junction box  
2 installed.  
3

#### 4 **9-29.2(2) Standard Duty and Heavy Duty Cable Vaults and Pull Boxes**

5 The first sentence of the second paragraph is revised to read:  
6

7 The Contractor shall provide shop drawings for all componants including concrete box,  
8 Cast Iron Ring, Ductal Iron Lid, Steel Rings,and Lid. In addition the shop drawings shall  
9 show placement of reinforcing steel, knock outs, and any other appertenances  
10

#### 11 **9-29.3 Conductors, Cable**

12 This section's content is deleted. This section's title is revised to read:  
13

#### 14 **9-29.3 Fiber Optic Cable, Electrical Conductors, and Cable**

##### 15 **9-29.3(1)A Singlemode Fiber Optic Cable**

16 This section is revised to read:  
17

18  
19 Singlemode fibers utilized in the cables specified herein shall be fabricated from 100  
20 kpsi proof stress glass and primarily composed of silica which shall provide a matched  
21 clad index of refraction (n) profile and the following physical and performance  
22 characteristics:  
23

- 24 1. Maximum Attenuation: 0.4/0.3 dB/km at 1310/1550 nanometers, respectively;
- 25 2. Typical Core Diameter: 8.3 microns;
- 26 3. Cladding Diameter: 125 micron;
- 27 4. Core-to-Cladding Offset (Defined as the distance between the core center and  
28 the cladding center: < 0.8 microns;
- 29 5. Cladding Non-Circularity (Defined as {[1-(minimum cladding diameter -  
30 maximum cladding diameter)] X 100.}; < 2.0%;
- 31 6. Coating Diameter of 250 microns ± 15 microns with a minimum coating  
32 thickness at any point of not less than 50 microns;
- 33 7. The coating shall be a dual-layered, UV-cured acrylate applied by the fiber  
34 manufacturer; and,  
35 8. The coating shall be mechanically or chemically strippable without damaging  
36 the fiber.  
37  
38  
39  
40  
41  
42  
43  
44

##### 45 **9-29.3(2) Twisted-Pair (TWP) Copper Cable**

46 This section's content is deleted. This section's title is revised to read:  
47

#### 48 **9-29.3(2) Electrical Conductors and Cable**

49 This section is supplemented with the following new sub-sections:  
50  
51

1	<b>9-29.3(2)A Single Conductor</b>
2	
3	<b>9-29.3(2)A1 Single Conductor Current Carrying</b>
4	All current carrying single conductors shall be stranded copper conforming to ASTM B3
5	and B8. Insulation shall be chemically XLP (cross-linked polyethylene) or EPR (Ethylene
6	Propylene Rubber) Type USE rated for 600 volt.
7	
8	<b>9-29.3(2)A2 Grounding Electrode Conductor</b>
9	Grounding electrode conductor shall be bare or insulated stranded copper. The
10	insulation shall be green or green with a yellow tracer.
11	
12	<b>9-29.3(2)A3 Equipment Grounding and Bonding Conductors</b>
13	Equipment grounding and bonding jumper conductors shall be bare or green insulated,
14	stranded copper with cross-linked polyethylene insulation rated USE and 600 volts,
15	with the exception that the equipment grounding and bonding jumper conductors
16	installed between junction box, pull box, or cable vault frame and lids shall be tinned,
17	braided copper.
18	
19	<b>9-29.3(2)A4 Location Wire</b>
20	Location wire shall be a single stranded copper size AWG 14 insulated conductor. The
21	insulation shall be type USE Orange in color.
22	
23	<b>9-29.3(2)B Multi-Conductor Cable</b>
24	Two conductor through 10 conductor unshielded signal control cable shall conform to
25	International Municipal Signal Association (IMSA) signal cable Specification 20-1.
26	
27	<b>9-29.3(2)C Aluminum Cable Steel Reinforced</b>
28	Triplex or Quadraplex type ACSR neutral self-supporting aerial conductors of the
29	appropriate size for aluminum conductors shall be used where required in the Contract.
30	The neutral conductor shall be the same size as the insulated conductor. All conductors
31	shall be stranded.
32	
33	<b>9-29.3(2)D Pole and Bracket</b>
34	Pole and bracket cable shall be a two-conductor cable rated for 600 volts. The individual
35	conductors shall be one red and one black 19-strand No. 10 AWG copper, assembled
36	parallel. The conductor insulation shall be 45-mil polyvinyl chloride or a 600 volt rated
37	cross-linked polyethylene. The Jacketing shall be polyethylene or polyvinyl chloride not
38	less than 45-mils thick. If luminaires with remote ballasts are specified in the Contract,
39	this same cable shall be used between luminaire and ballast for both timber and
40	ornamental pole construction. If the luminaire requires fixture wire temperatures greater
41	than 75°C, the outer jacket shall be stripped for that portion of the cable inside the
42	luminaire. The single conductors shall then be sheathed with braided fiberglass sleeving
43	of the temperature rating recommended by the luminaire manufacturer.
44	
45	<b>9-29.3(2)E Two-Conductor Shielded</b>
46	Two conductor shielded (2CS) cable shall have 14 AWG (minimum) conductors and
47	shall conform to IMSA Specification No. 50-2.
48	
49	<b>9-29.3(2)F Detector Loop Wire</b>
50	Detector loop wire may be 12 or 14 AWG stranded copper wire, IMSA 51-3
51	

1 **9-29.3(2)G Four-Conductor Shielded Cable**

2 Four conductor shielded cable (4CS) shall consist of a cable with four 18 AWG  
3 conductors with polypropylene insulation, an aluminized polyester shield, water blocking  
4 material in the cable interstices, and a 26-mil minimum outer jacket of polyethylene. The  
5 four-conductor assembly shall be twisted 6 turns per foot. Each conductor shall have a  
6 different insulation color. Overall cable diameter shall be 0.25-inch maximum.  
7 Capacitance between adjacent pairs shall be 18 pf per foot and 15 pf per foot between  
8 diagonal pairs. The capacitances shall not vary more than 10 percent after a 10-day  
9 immersion test with ends exposed in a saturated brine solution.

10  
11 **9-29.3(2)H Three-Conductor Shielded Cable**

12 Three-conductor shielded cable (3CS) for the detector circuit for optical fire preemption  
13 receivers shall consist of three 20 AWG conductors with aluminized mylar shield and  
14 one No. 20 drain wire, all enclosed with an outer jacket. All wires shall be 7 X 28  
15 stranded tinned copper material. Conductor insulation shall be rated 75°C, 600 volt. The  
16 drain wire shall be uninsulated. Conductor color coding shall be yellow, blue, and  
17 orange. DC resistance of any conductor or drain wire shall not exceed 11 ohms per  
18 1,000-feet. Capacitance from one conductor to the other two conductors and shield  
19 shall not exceed 48 pf per foot. The jacket shall be rated 80 degree C, 600 volt, with a  
20 minimum average wall thickness of 0.045-inch. The finished outside diameter of the  
21 cable shall be 0.3-inch maximum.

22  
23 **9-29.3(2)I Twisted Pair Communications Cable**

24 Twisted Pair Communications Cable shall meet RUS Specification 1755.390 and shall  
25 be AWG22 conductor. The cable shall have a petroleum compound completely filling  
26 the inside of the cable and rated for OSP (Outside Plant) applications.

27  
28 **9-29.6 Light and Signal Standards**

29 This section is supplemented with the following:

30  
31 Materials for steel light and signal standards, and associated anchorage and fastening  
32 hardware, shall conform to Sections 9-29.6(1), 9-29.6(2) and 9-29.6(5) unless otherwise  
33 specified in one of the following documents:

- 34  
35 1. The steel light and signal standard fabricator's pre-approved plan as approved  
36 by the Washington State Department of Transportation and as identified in the  
37 Special Provisions.  
38  
39 2. The steel light and signal standard fabricator's shop drawing submittal,  
40 including supporting design calculations, as submitted in accordance with  
41 Sections 6-01.9 and 8-20.2(1) and the Special Provisions, and as approved by  
42 the Engineer.  
43

44 **9-29.10 Luminaires**

45 Item G. under the first paragraph is revised to read:

- 46  
47 G. Housings shall be fabricated from aluminum. Painted housings shall be painted flat  
48 gray, Federal Standard 595 color No. 26280. Housings that are painted shall  
49 withstand a 1,000-hour salt spray test as specified in ASTM B 117.  
50



1 **9-29.10(2) Decorative Luminaires**

2 The reference to "Federal Standard 595B" in the third sentence of the sixth paragraph is  
3 revised to "Federal Standard 595".  
4

5 **9-29.10(3) High Mast Luminaires and Post Top Luminaires**

6 The second sentence of the third paragraph is revised to read:  
7

8 All housings shall be painted flat gray, Federal Standard 595 color No. 26280.  
9

10 **9-29.16(2)E Painting Signal Heads**

11 The reference to "Federal Standard 595B" in the first sentence is revised to "Federal  
12 Standard 595".  
13

14 **9-29.20 Pedestrian Signals**

15 Under the second paragraph in item B(3) the reference to "Federal Standard 595B" is  
16 revised to "Federal Standard 595".